Predation of Juvenile Chinook Salmon by Predatory Fishes in the Cedar River

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Abstract

Within the Lake Washington basin, an important, wild run of chinook salmon occurs in the Cedar River. Juvenile chinook salmon are present in the Cedar River from January to July. Juvenile chinook salmon appear to have two rearing strategies; rear in the river and then emigrate in May or June as pre-smolts, or emigrate as fry in February or March and rear in the lake for several months. Because much of the Cedar River is channelized and little woody debris is present, chinook salmon may be limited by habitat and thus most may emigrate to Lake Washington to rear. We hypothesize that juvenile chinook salmon select complex habitat, such as off-channel habitats, because it provides refuge from predators. Juvenile chinook salmon that inhabit these sites for an extended period of time may have higher survival rates than those rearing in the lake or other locations. Predation may occur primarily in the main channel as they emigrate to the lake or as they reside in the lake. An important question to chinook salmon management is whether it is better for chinook salmon to rear in the lake or the river. The main objectives of this study were to identify important fish predators of juvenile chinook salmon, estimate total predation by these predators, and determine the importance that habitat type and other environmental factors have on predation rates of juvenile chinook salmon. We planned to compare predation rates in the river to those in the lake. Sampling in the lake was not done in 2000 but we may be able to use data collected in 1995 and 1996. Additionaly, we examined habitat segregation between chinook salmon and predatory fishes.

Sampling consisted of two types; sampling of various habitat types to examine spatial differences in predation, and sampling of index sites to examine temporal differences in predation. Overall, predation rates were low. We examined the stomach contents of 1,880 fish, only 17 juvenile chinook salmon were found. Most observed predation (76%) was by large trout, rainbow trout or cutthroat trout. In areas where we found that trout or coho salmon were abundant, chinook salmon abundance was usually low. In areas where chinook salmon were abundant, large predators were usually rare. No predation of chinook salmon was observed in off-channel areas. Predation occurred in large, deep lateral scour pools, either on the scour side or in depositional areas. Because chinook salmon rarely inhabit these sites, they may be captured as they emigrate downstream. Thus, there may be some degree of risk in emigrating to the lake as fry. Using an habitat-based model, our preliminary estimate of the total predation of chinook salmon was 9,300 fish; 6,200 chinook salmon consumed by trout and 3,100 chinook salmon consumed by sculpins. We examined data collected in 1998 during hatchery releases of sockeye salmon fry. Similarly to 2000 data, most predation appeared to occur in pool habitat in the main channel. However, one chinook salmon was found in a trout captured in an off-channel area.

Abstract, continued

We examined day and night habitat segregation between chinook salmon and predatory fishes at two sites on two dates, one in March when chinook salmon were small (35-45 mm) and another in June when chinook salmon were considerably larger (80-100 mm). In March, chinook salmon were in low-velocity areas and in moderately shallow water during the day. Few predators were present during the day. At night, good numbers of trout and sculpin were observed. They inhabited deep to moderately-shallow water. Chinook salmon moved into shallow water close to shore and appeared segregated from the predators. In June, the distribution of chinook salmon during day and night appeared to overlap that of trout and sculpin. Chinook salmon inhabited deeper and higher-velocity waters in June than they did in March.

In conclusion, predation of chinook salmon by predatory fishes in the Cedar River was low. Small juvenile chinook salmon appear to select complex habitat, such as off-channel habitats, because it provides refuge from predators. The highest amount of predation probably occurs as chinook salmon emigrate to the lake. Further analyses will include: 1) complete 2000 data, 2) complete 1998 data, 3) examine 1995 and 1996 lake predation data, and 4) determine habitat segregation of chinook salmon and predators from 1999 data.

Objectives

- Assess in-river survival versus lake survival
- Estimate predation loss to fish predators
- Compare main channel and lateral habitat areas
- Examine habitat segregation between chinook and predators

Methods

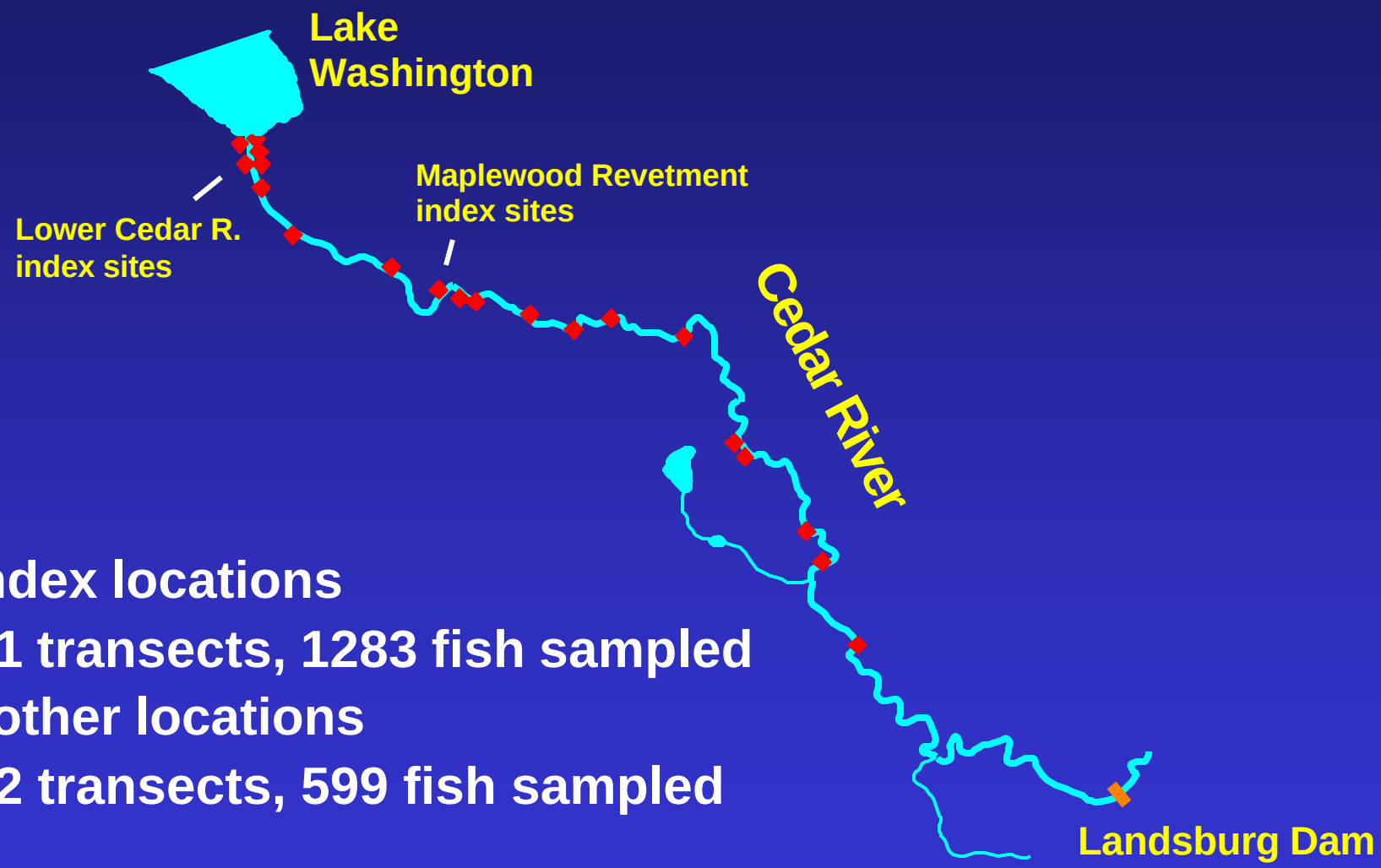
- Night snorkel estimates made using bounded count
- Collected predators with electrofishing equipment or small dip nets
- Two index sites and 13 other locations sampled
- Habitat classified similar to 1999 Cedar River chinook habitat study (see R. Peters et al. these proceedings)

Predatory Fishes

- **Salmonids**
  - Cutthroat trout
  - Rainbow trout/steelhead
  - Coho salmon
- **Sculpin**
  - Torrent sculpin
  - Riffle sculpin
  - Coastrange sculpin
  - Prickly sculpin

Cedar River Sample Sites

January-May, 2000



2 index locations

61 transects, 1283 fish sampled

13 other locations

32 transects, 599 fish sampled

Predator species

Table 1.– Number of predator stomachs examined (N) and the number of juvenile chinook salmon observed in those samples from the Cedar River, January-April, 2000.

Species	N	chinook
Salmonids	483	15
Coho salmon	104	2
Cutthroat trout	91	3
Rainbow trout / steelhead	251	10
Unidentified trout	37	0
Cottids	1397	2
Coastrange sculpin	95	0
Prickly sculpin	478	0
Riffle sculpin	234	0
Torrent sculpin	583	2

Sample type

Table 2.– Number of predator stomachs examined (N) and the number of juvenile chinook salmon observed in those samples from two sampling strategies in the Cedar River, January-April, 2000.

Sample type	N	chinook
Habitat sites	**599**	**7**
Trout	**134**	**6**
Coho salmon	**20**	**0**
Sculpin	**445**	**1**
Index sites	**1283**	**10**
Trout	**245**	**7**
Coho salmon	**84**	**2**
Sculpin	**952**	**1**

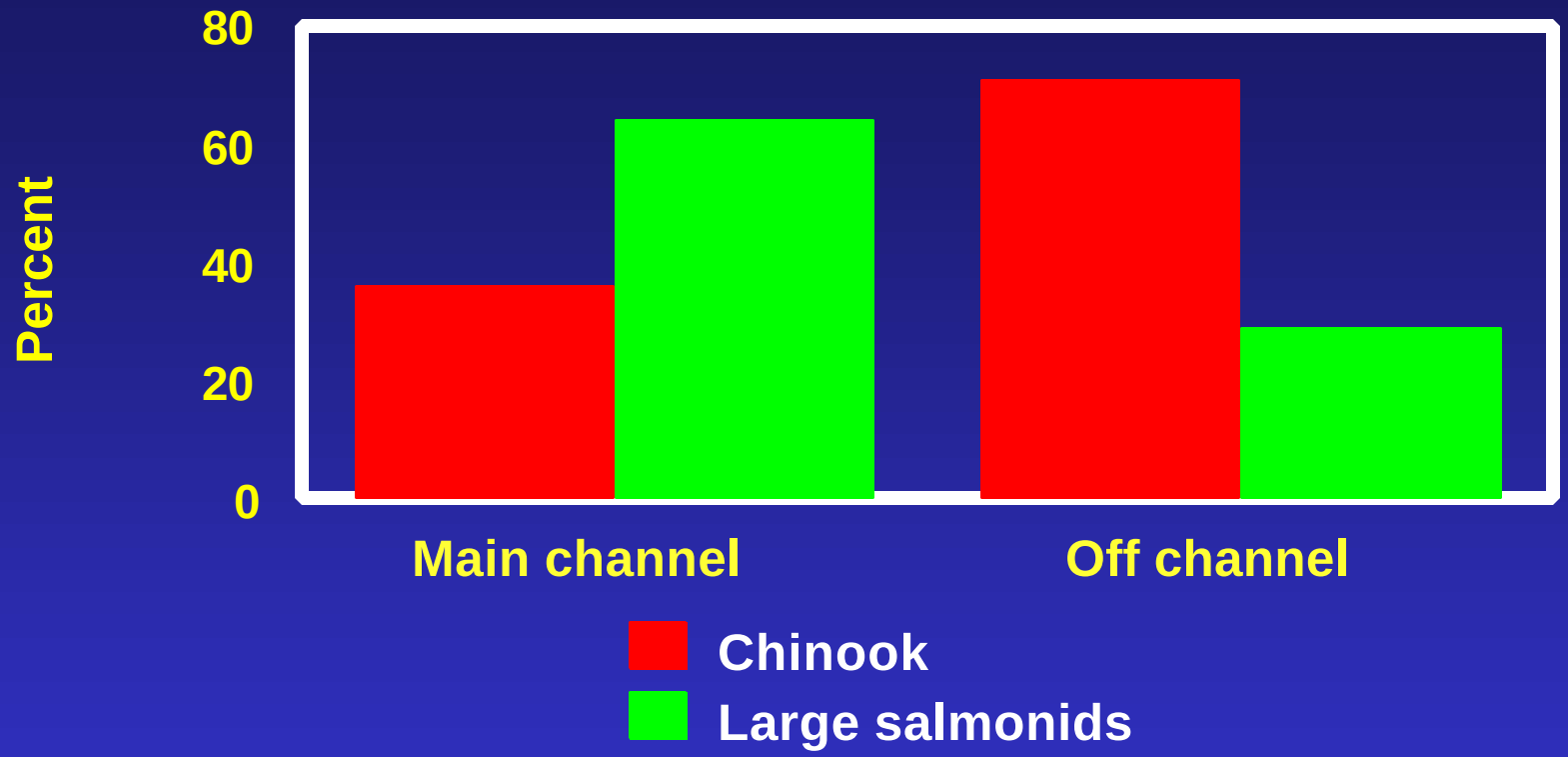


Figure 1.– Ratio of juvenile chinook salmon to other salmonids (rainbow trout, cutthroat trout, and coho salmon) in two channel types, Cedar River, January-April, 2000. Fish abundance was based on snorkeling counts.

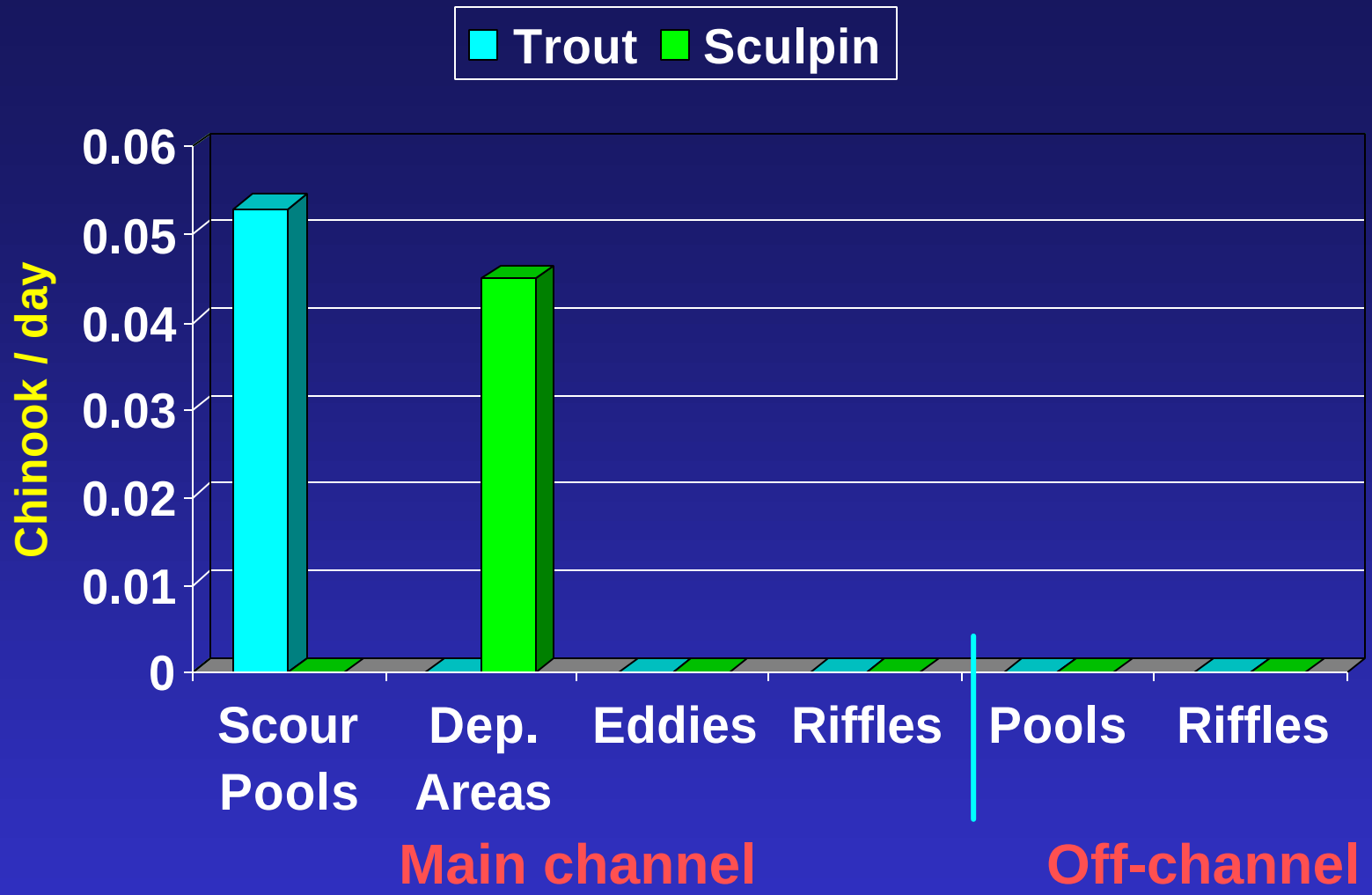


Figure 2.– Consumption rate (chinook/day) of two predator types from two channel types, Cedar River, January-April, 2000. Dep. Areas = depositional areas.

Consumption estimate

- Preliminary estimate
- Population size: Trout – bounded counts; sculpin – mark-recapture data
- Duration: Trout – 75 day period; sculpin – 45 day-period
- Habitat-based model used – 1998 survey data used
- Total estimate: 9,284 chinook (6,221 by trout and 3,063 by sculpin)

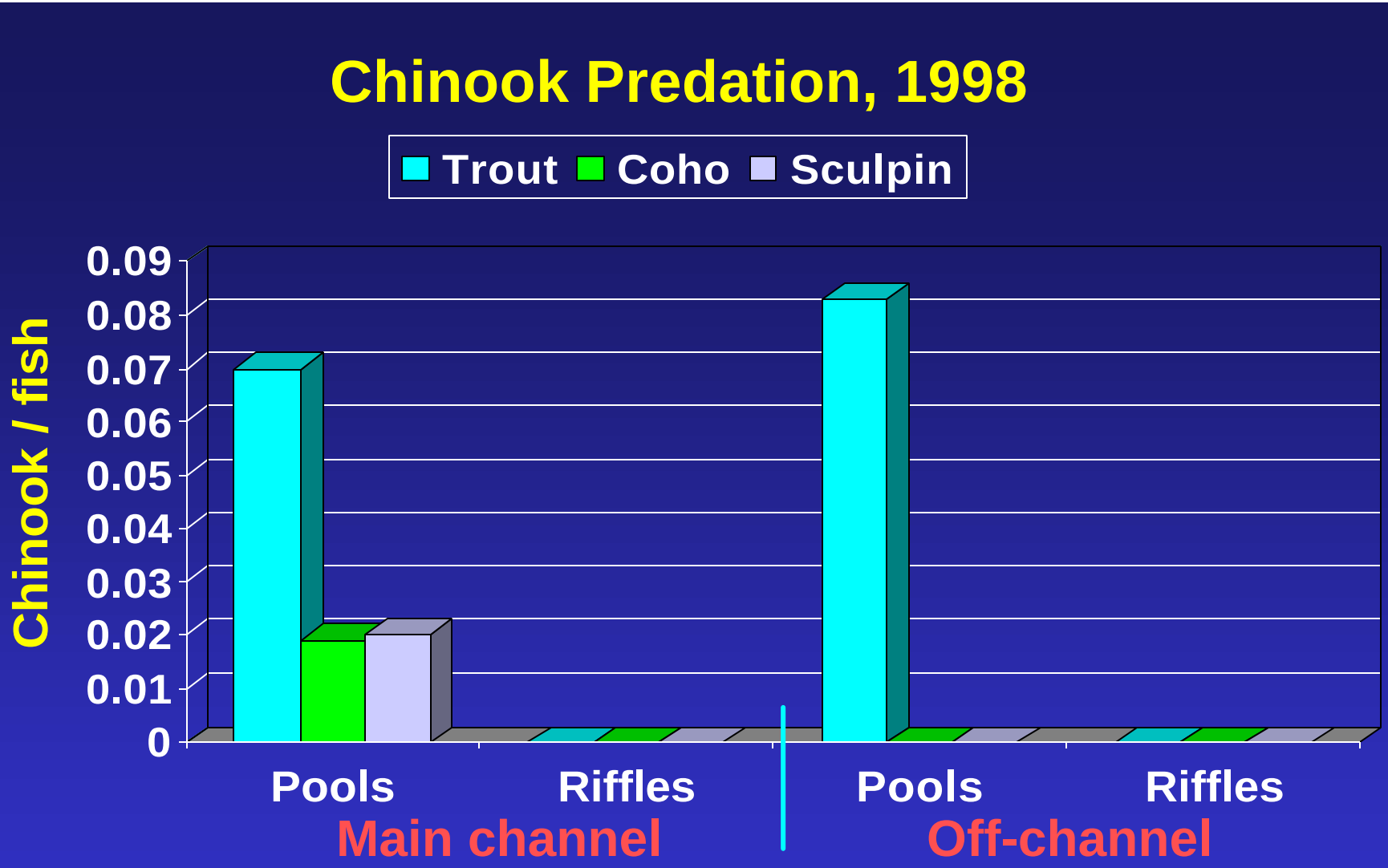


Figure 3.– Predation of chinook by three predator types from two channel types, Cedar River, February-March, 1998. Data were collected on nights when hatchery sockeye salmon fry were released.

Habitat segregation

- We examined two sites with chinook, sculpin, and trout
- Two dates (day and night), one in March, 2000 and one in June, 2000
- Variables included: depth, focal velocity, substrate use, and distance to shore and cover

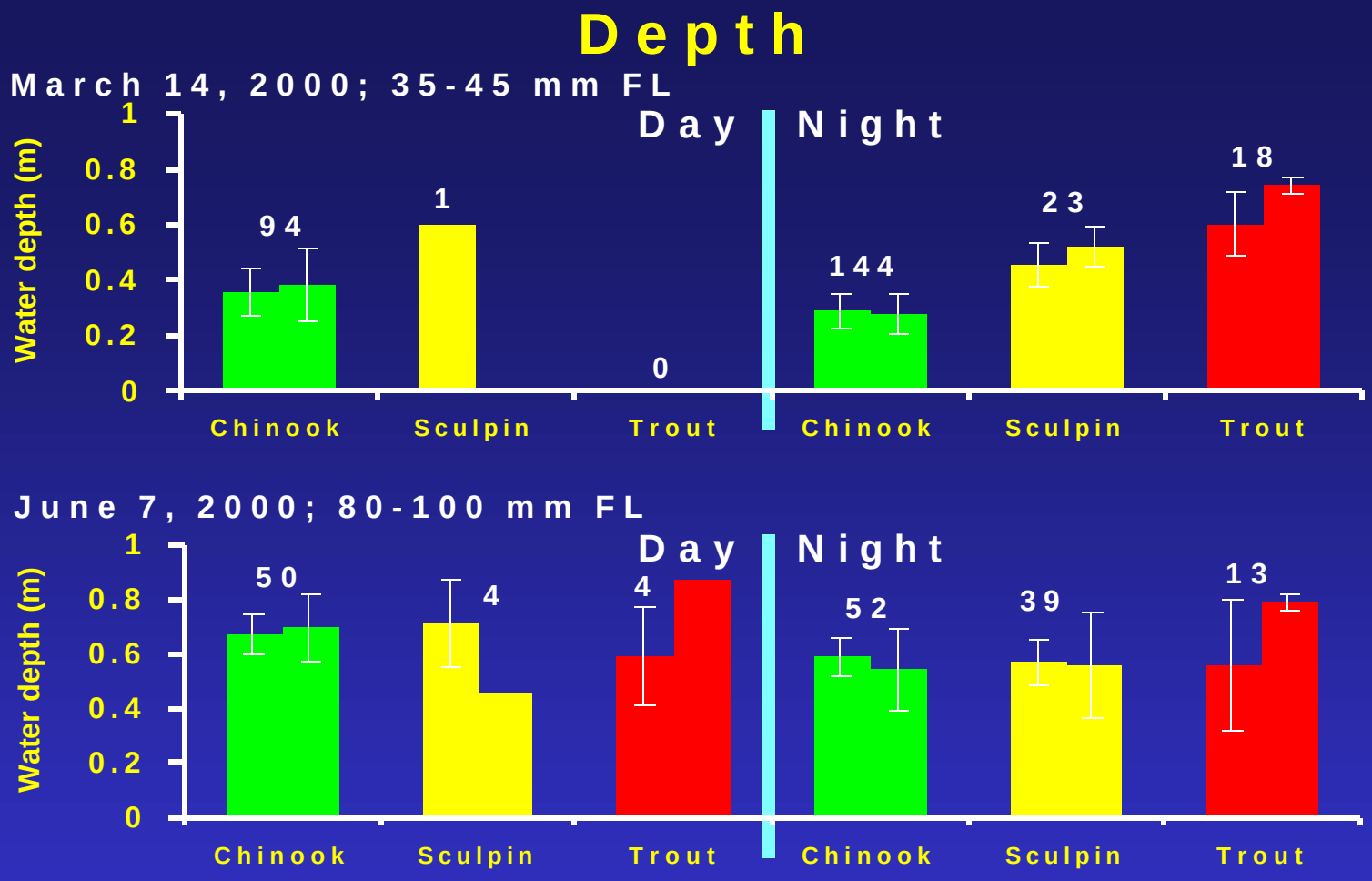


Figure 5.– Mean water depth (+/- 2SE) during day and night at two sites in the Cedar River, 2000. Water depth is the total depth of the water column at the fish's location. The numbers above the bars represents the total number of fish observed at the two sites. Each pair of bars represents the two study sites; left: small pool in the Elliot side channel (Rkm 7.4), right: small back eddy pool at Rkm 13.2.

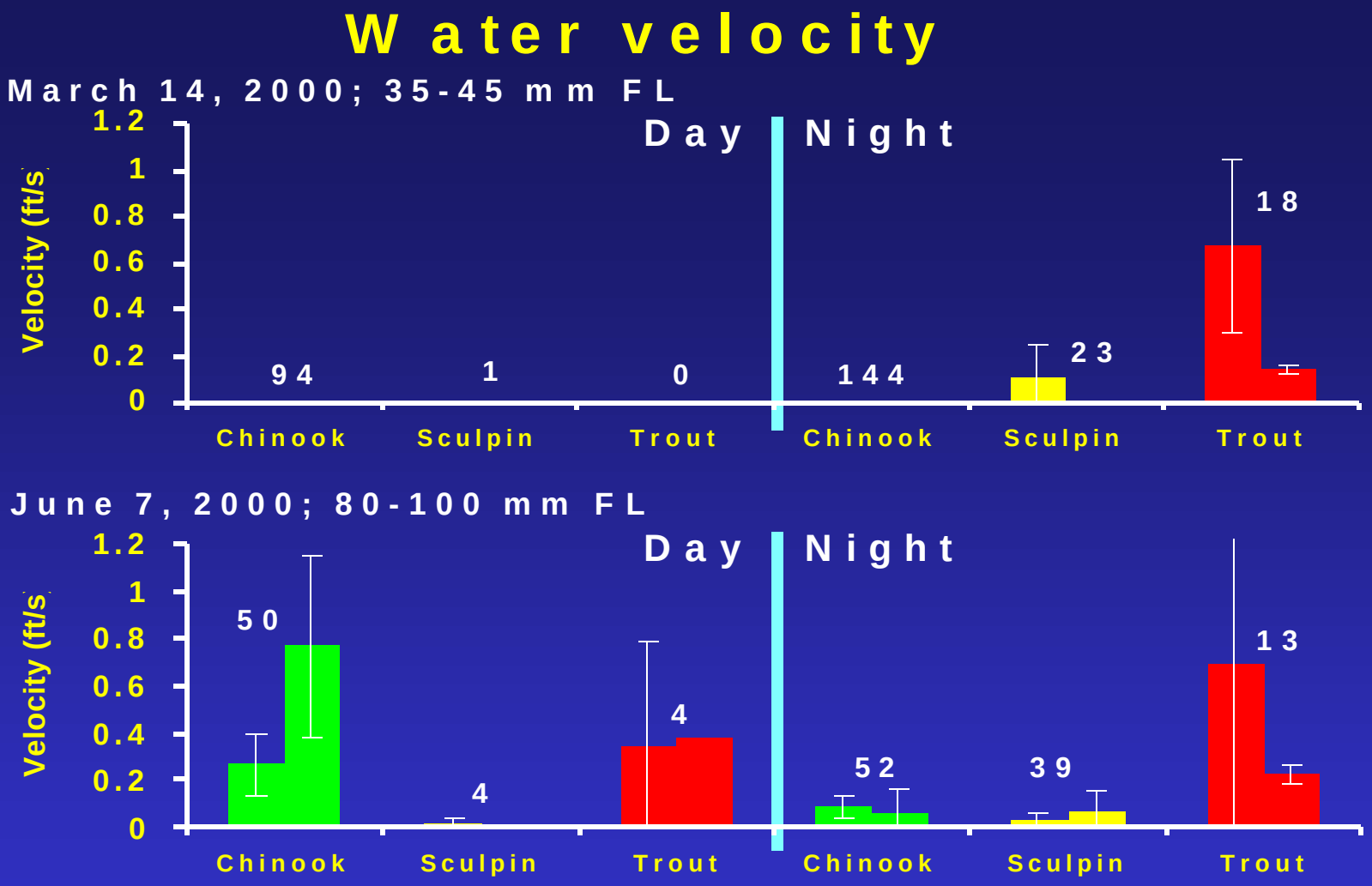
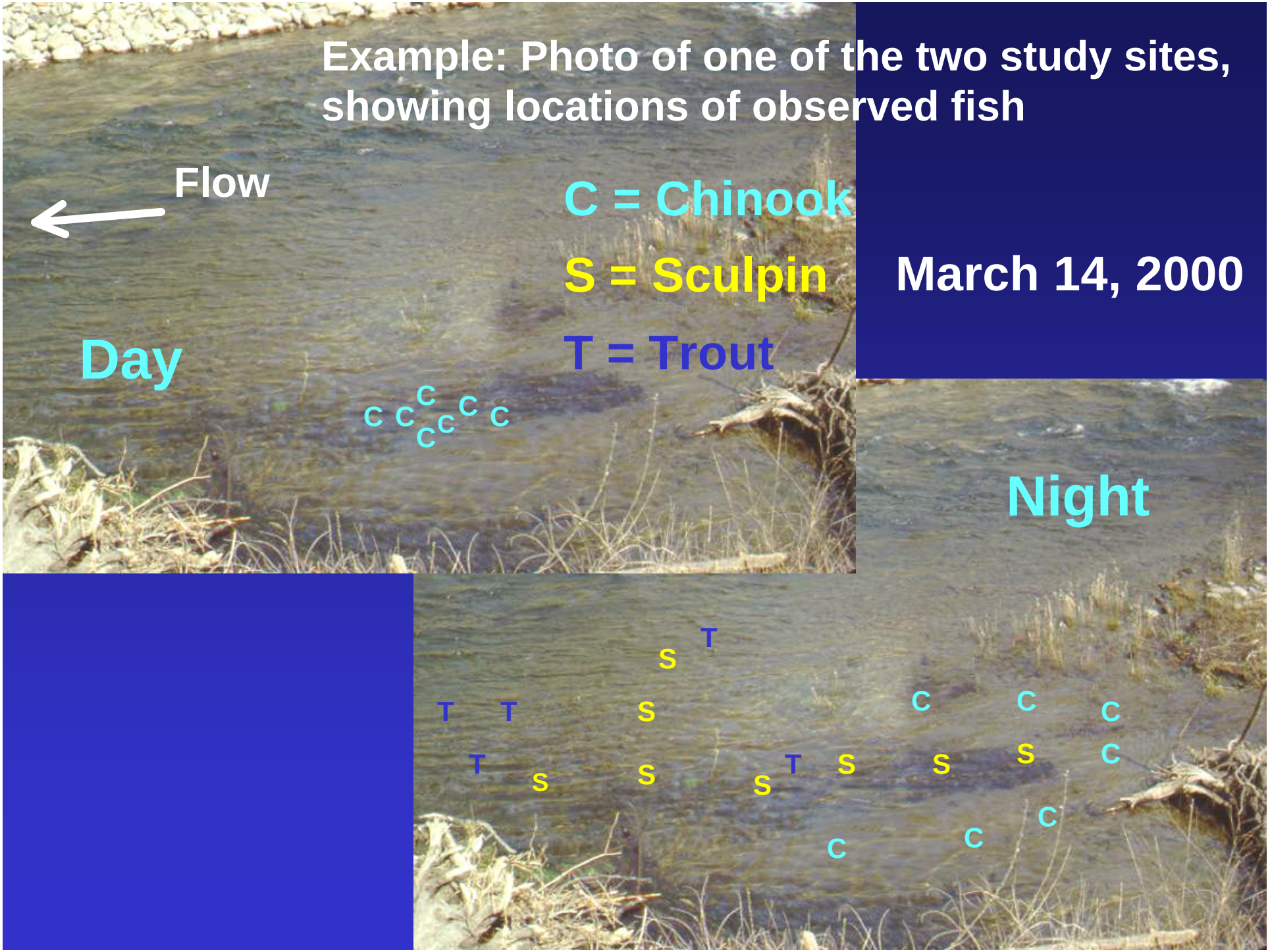
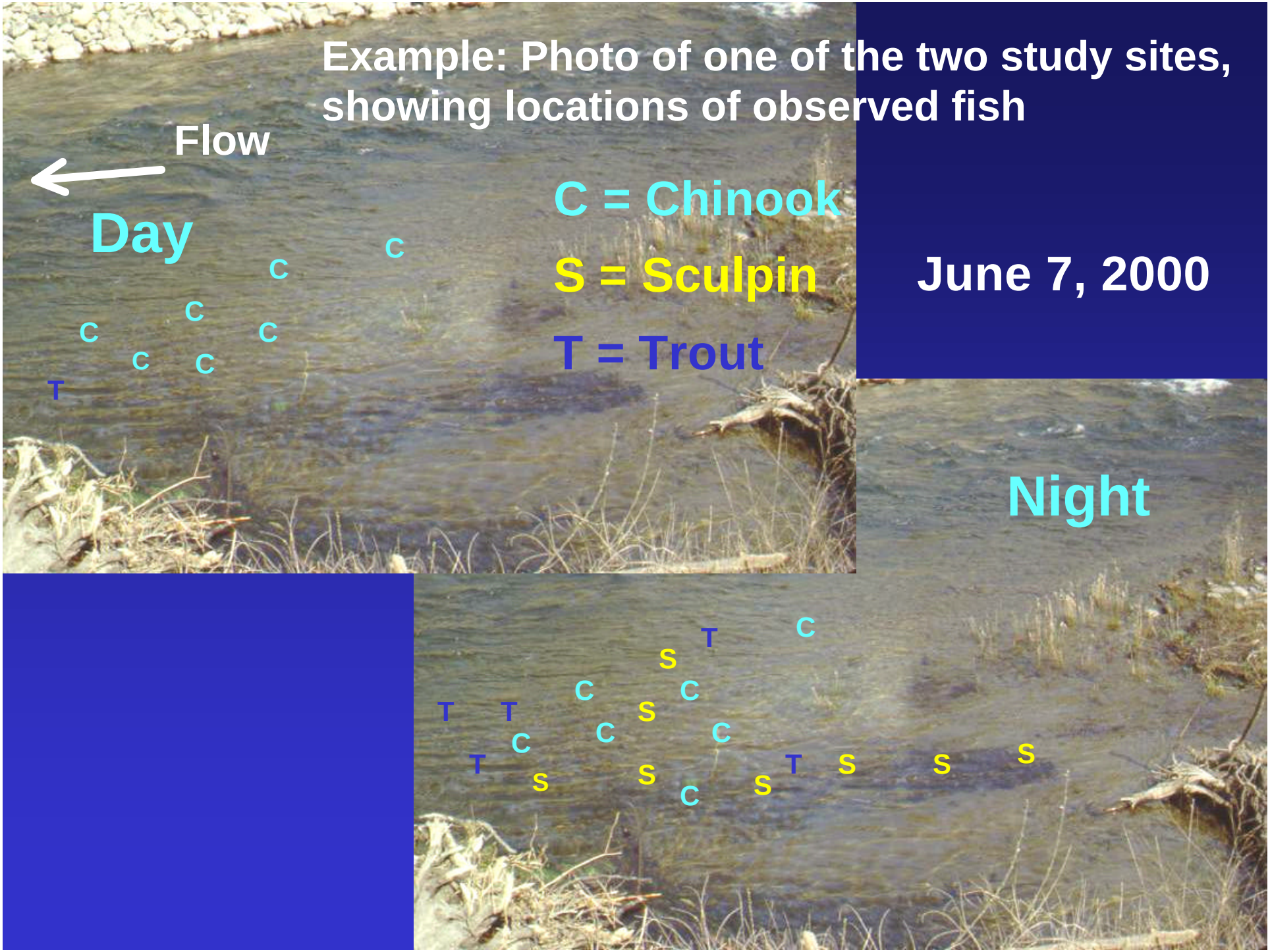


Figure 5.– Mean focal velocity (+/- 2SE) during day and night at two sites in the Cedar River, 2000. The numbers above the bars represents the total number of fish observed at the two sites. Each pair of bars represents the two study sites; left: small pool in the Elliot side channel (Rkm 7.4), right: small back eddy pool at Rkm 13.2.


Example: Photo of one of the two study sites, showing locations of observed fish
Flow
C = Chinook
S = Sculpin
T = Trout
March 14, 2000
Day
Night


Example: Photo of one of the two study sites, showing locations of observed fish
Flow
Day
C = Chinook
S = Sculpin
T = Trout
June 7, 2000
Night

Conclusions

- Predation rates of chinook were low
- Predation occurred in large pool habitat
- Small juvenile chinook were spatially segregated from potential predators

Further Analyses

- Complete 98 and 00 predation estimates
- Compare in-river predation (00 data) to lake predation (95 and 96 data)
- Examine habitat segregation from 99 Cedar River chinook habitat data